The National Energy Technology Laboratory

Strategic Center for Natural Gas

Strategic Center for Natural Gas

"... I am also announcing today that I will establish, within this facility, a new Center for Advanced Natural Gas Studies."

"We need one place that looks out for the future of natural gas -- from borehole to burnertip. One place that understands the innovations needed to produce tomorrow's gas."

"In other words, we need a strategic center that looks at the big picture and devises the bold ideas that allow the FULL potential of natural gas to be achieved. And I want that center to be located at this Laboratory."

Bill Richardson, Secretary of Energy

December 10, 1999

Strategic Center for Natural Gas

Vision:

By 2020, U.S. public is enjoying benefits from an increase in gas use:

- Affordable supply
- Reliable delivery
- Environmental protection

Mission:

Be the focal point for an integrated gas program:

- Spearhead annual DOE-wide gas RD&D planning and program assessment
- Provide science and technology advances through NETL's on-site programs
- Shape, fund, and manage extramural RD&D
- Conduct studies to support policy development

RD&D Programs

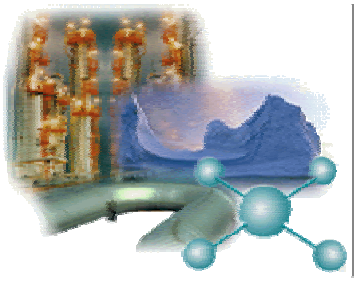
Strategic Center for Natural Gas

Gas Exploration & Production

- Resource and reserve assessments
- Improved drilling and completion technologies for low-perm/deep gas
- Hydrates, deep gas and off-shore

Gas Infrastructure Reliability

- Enhance pipeline safety & reliability
- Increase gas deliverability
- Increase operational flexibility of gas
- storage facilities



Distributed Generation

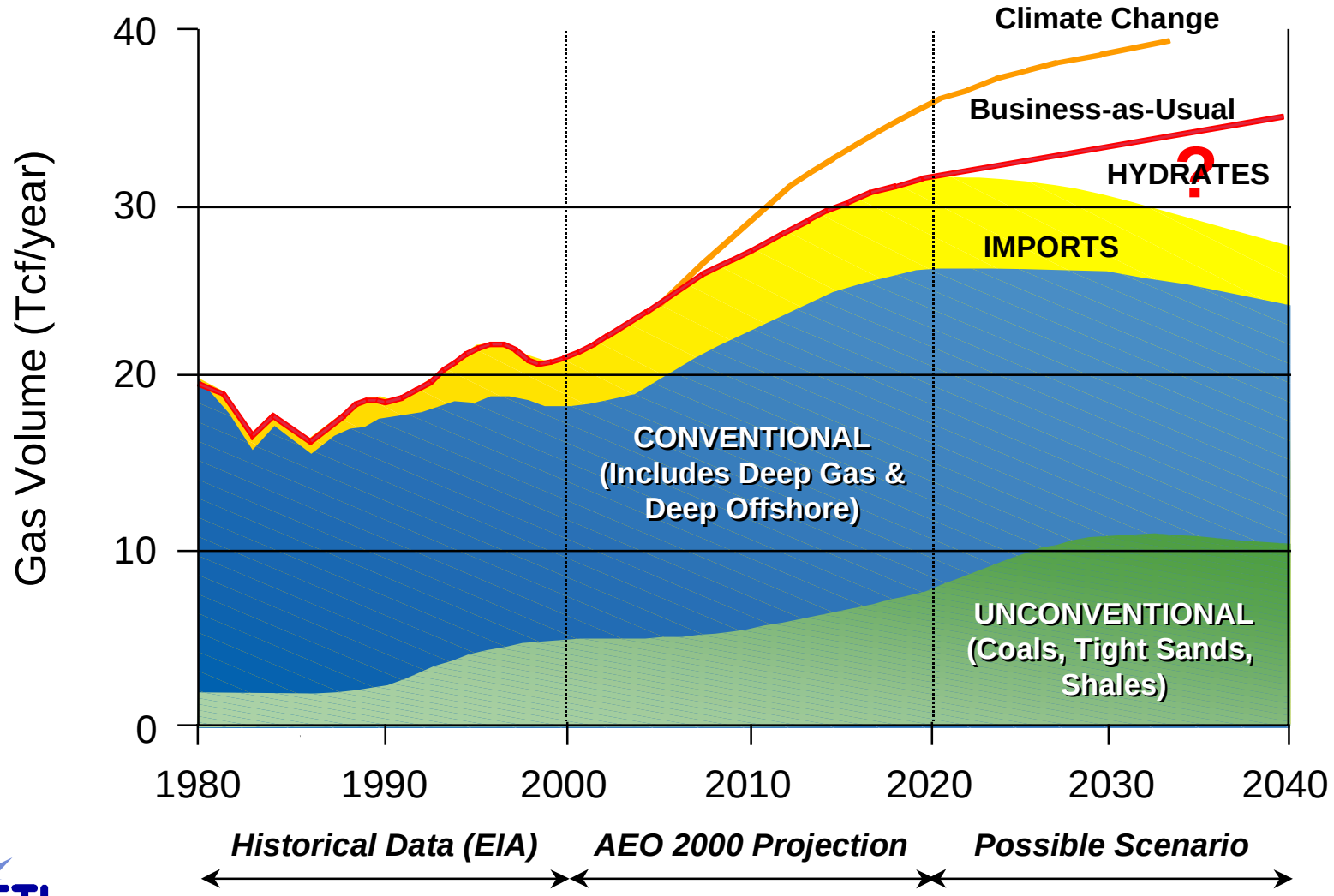
- PAFC - entering commercial market
- MCFC - high efficiency
- SOFC/SECA - low cost
- Hybrid turbine/fuel cell - ultimate
- efficiency
- Reciprocating engines - lowest cost

Next Generation Gas Turbines for Large Industries / Utilities

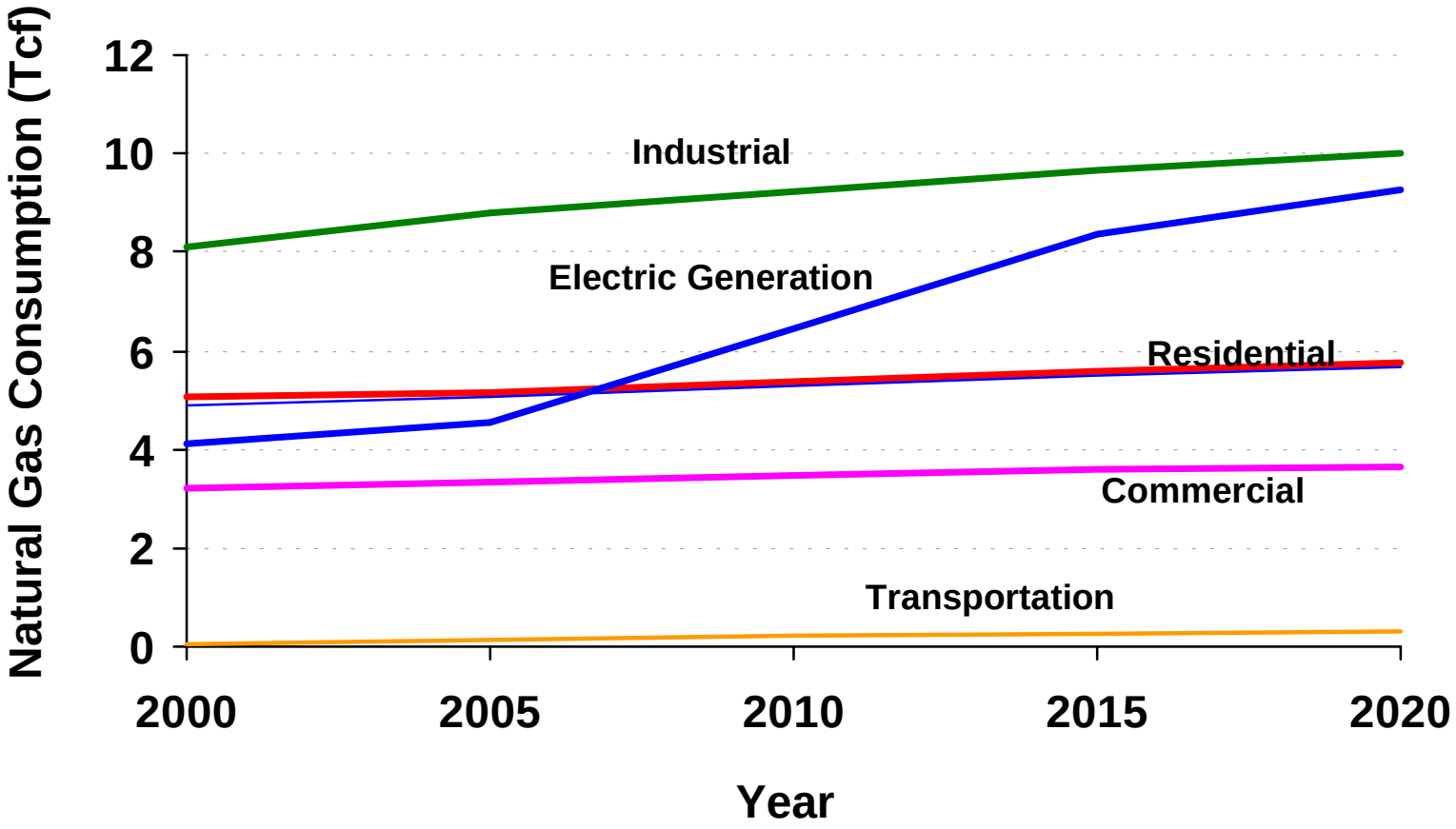
- Flexible 30-300 MW turbine systems
- RAM Improvement
- Supporting R&D

NETL

Enough Affordable Natural Gas to Meet Demand?



Projected Natural Gas Consumption 2000-2020



Source: AEO 2000

Natural Gas Exploration and Production

- Near-term: recover more from known fields
- Mid-term: unlock low perm resources containing natural fractures
- Long-term: encourage exploration for deep gas and hydrates

Developing Technologies to Ensure an Abundant, Economical Supply of Natural Gas With Minimal Environmental Impact

Gas Hydrates

Turning a Problem into a Potential Resource

- **A huge worldwide resource**
  - Oceans: 30,000 to 49,100,000 Tcf
  - Continents: 5,000 to 12,000,000 Tcf
  - Conventional resource: 3,000 Tcf
- **A huge US resource**
  - If 1% recoverable: 3,200 Tcf
  - Conventional resource: 1,301Tcf
- **Program elements**
  - Resource characterization
  - Safety & seafloor stability
  - Global climate change
  - Production

Hydrate Authorization Bill Passed May 2000

- Requires government to coordinate
  - Energy, Interior, Defense, Commerce, NSF
- Mandates advisory panel from industry, academia, government

Fire in the Ice
The Deep Sea Dive for Methane Hydrates

The Alvin

Gas Infrastructure Reliability

- **Infrastructure includes:**
  - Transmission systems
  - Distribution systems
  - Gas storage

- **Program goals**
  - Enhance safety and reliability
  - Increase gas deliverability
  - Reduce environmental impact

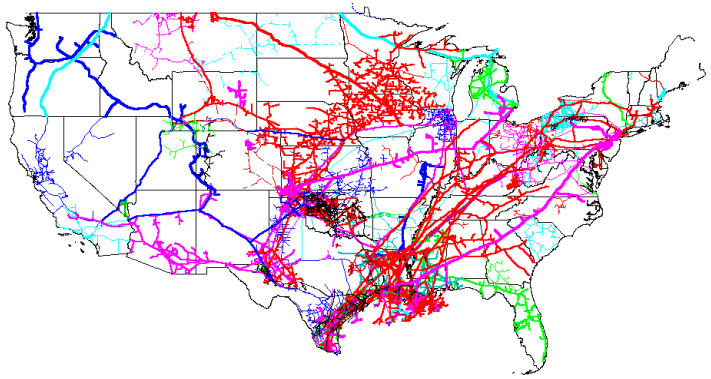
Infrastructure Activities

Visioning Workshop

- May 3, 2000
- Pittsburgh, PA
- 15 industry executives

Roadmapping Workshop

- June 6 & 7, 2000
- St. Louis, MO
- 40 industry experts



Goals

- Elicit stakeholder input
- Develop vision
- Identify technology needs & opportunities
- Determine government and industry roles

R&D Needs

From the Roadmapping Workshop . . .

Near Term

- Locatable plastic pipe
- Laser methane/ethane detectors
- Imaging and locating underground pipes
- Improve the permitting process

Mid Term

- Sensor on guided boring tool
- More sophisticated underground directional drilling
- Warning system on excavation equipment
- Integrity assessment
- New composite materials

Long Term

- Intrusion detection device
- 3-D subsurface facility locating techniques
- Multi-functional sensors (residual life, third party damage, mapping)
- High pressure composite pipe

Next Generation Turbine Systems
Program Elements

- **Systems Development**
  - Flexible Turbine Systems
  - Turbine/Fuel Cell Hybrids
  - Revolutionary Concepts
- **Power Plant Technology**
  - Condition monitoring, life prediction, performance and degradation models, cycle analysis, expert systems, performance optimization, prognostics, rotor dynamics, life management tools, operational optimization and life cycle cost reduction
- **Research and Development**
  - Low-emission combustion systems, materials, advanced computing, sensors, diagnostics, controls, monitoring

Fuel Cells for Stationary Power

Phosphoric Acid
ONSI 200-kW PAFC

Molten Carbonate
FCE 250-kW stack

Solid Oxide
Siemens Westinghouse
250-kW Hybrid

Proton Exchange Membrane

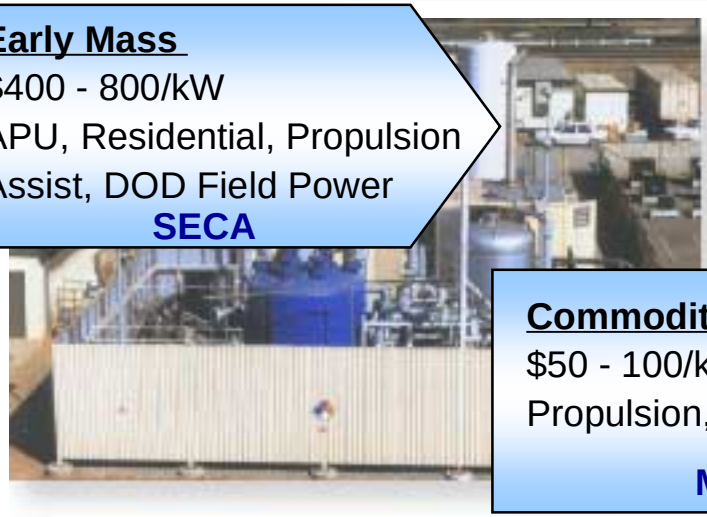
Fuel Cells: An Evolving Opportunity

2000 **2005** **2010** **2015**

Niche
$3,000 - 4,000/kW
Ultra-Reliability, Green
ONSI

Near-Term Distributed
$1,000 - 4,000/kW
Opportunity Fuels, Remote Sites
FCE, NWPS, Plug Power, SWPC

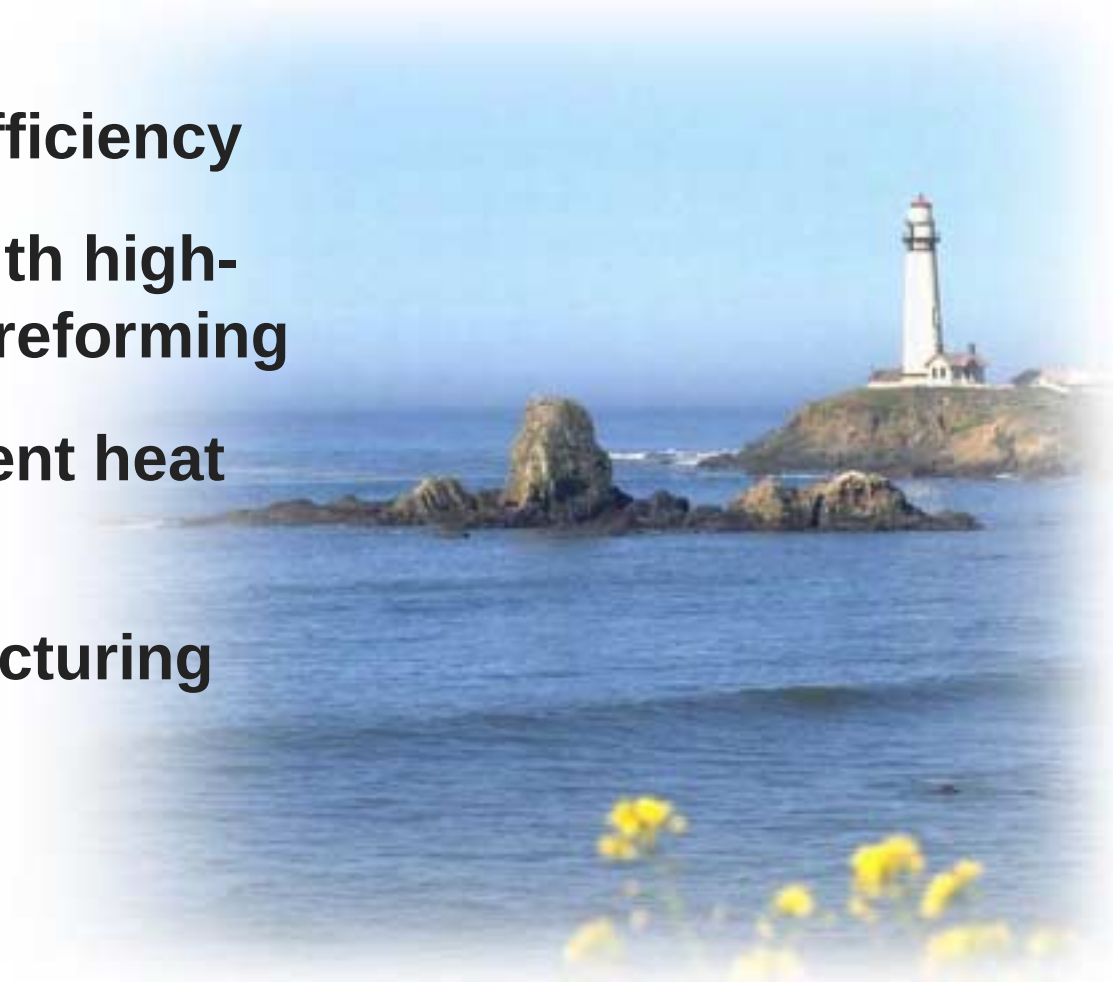
Early Mass
$400 - 800/kW
APU, Residential, Propulsion Assist, DOD Field Power
SECA



Commodity
$50 - 100/kW
Propulsion, Central Power
Many

Solid State Fuel Cells - The Choice for the New Millennium

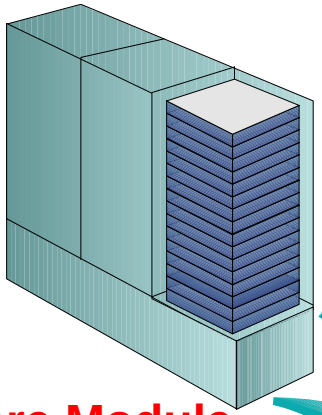
- Inherently high efficiency
- Couples easily with high-temperature fuel reforming
- Simple and efficient heat removal designs
- Low-cost manufacturing



Solid State Energy Conversion Alliance

A High Power Density, Low Cost Core Module for Multiple Applications

Transportation



Core Module

Stationary

Military

Key to Cost Reduction:
Mass Customization of Common Modules

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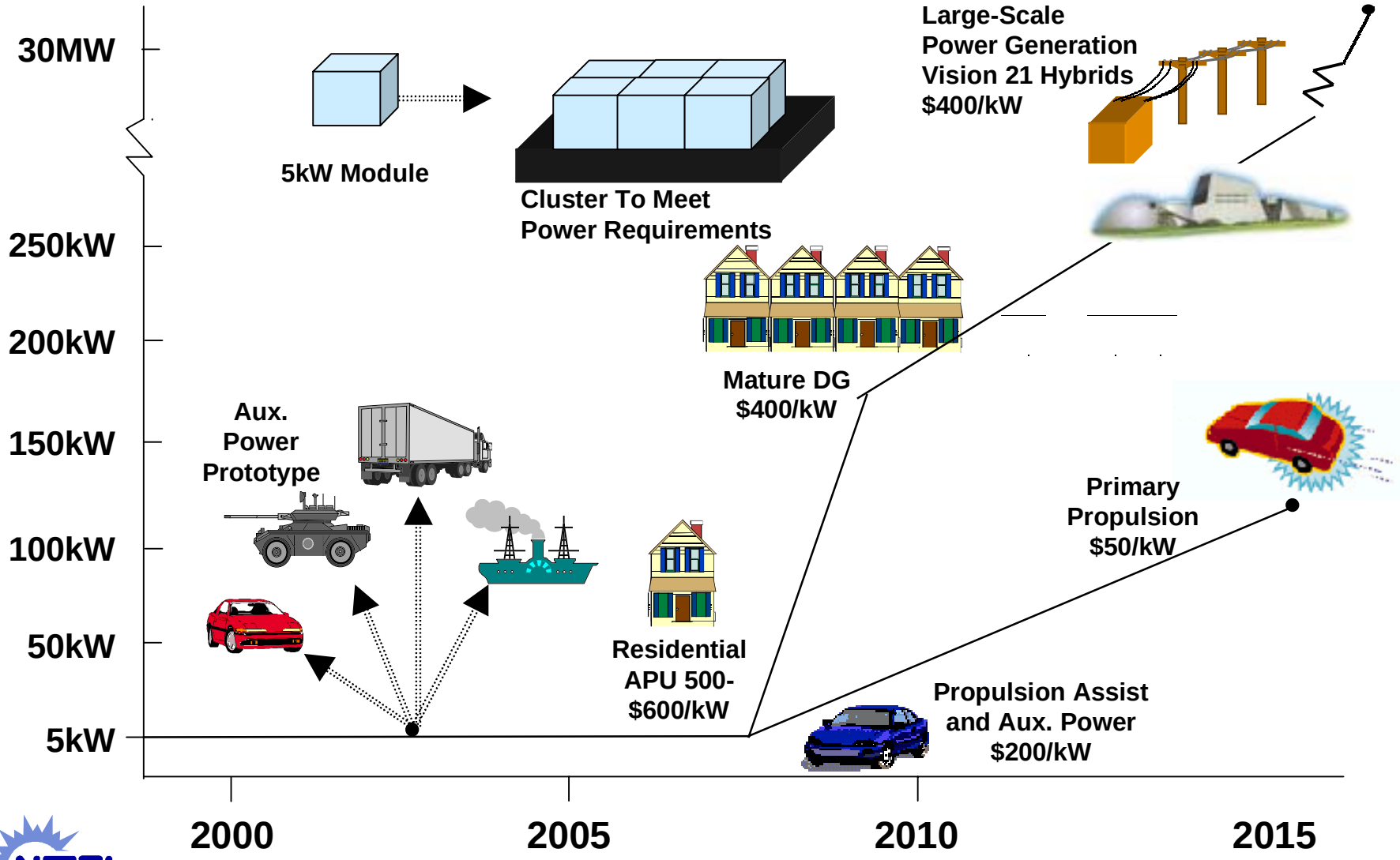
SECA Development: Progressive Applications



SECA Structure

Industry Input

Program Management

Department of Defense

Project Management

Needs

Research Topics

Industry Integration Teams

Technology Transfer

Core Technology Program

SECA Players

- Industry
- National Labs
- Advanced Research

Fuel Cell/Turbine Hybrids

2000

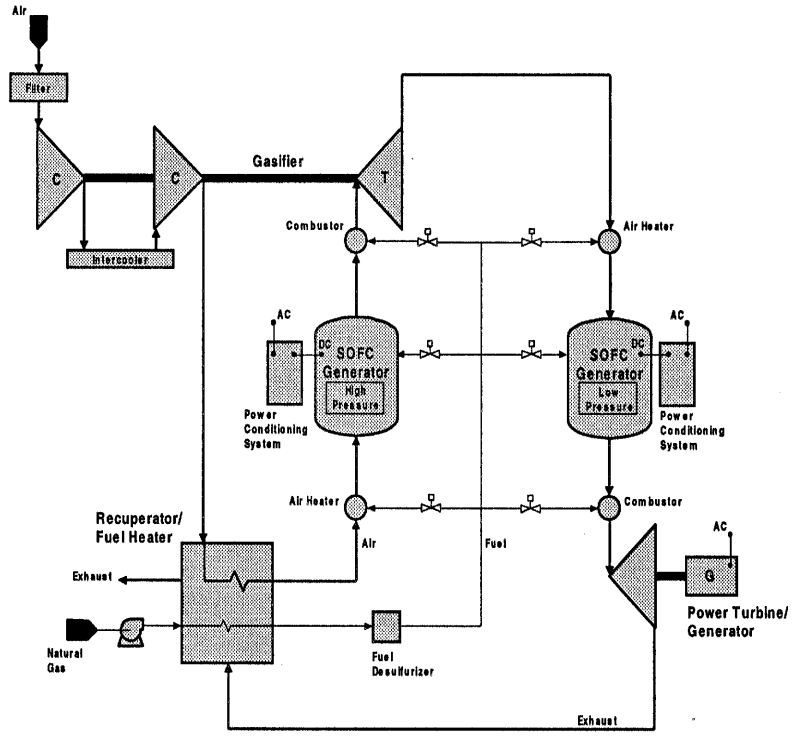
- > $10,000/kW
- 57-59% efficiency
- 220 kW

2004-2010

- DG market
- $1,000-1,200/kW
- 70% efficiency
- 1-20 MW

Vision 21 Fuel Cell/Turbine Hybrid Systems

- **Goals**
  - 70% (LHV) Electric Efficiency
  - 20MW or Less
  - Commercialization by 2010
- **Players**
  - SWPC/Allison
  - SWPC/Caterpillar
  - FCE/Allison
  - MCP/NREC
  - McDermott/NREC
- **Vision 21 Award to FCE/Capstone**
- **Solicitation issued in FY-2000**



Vision 21
Ultra-Clean Energy Plant of Future

Energy Plants for Post-2015

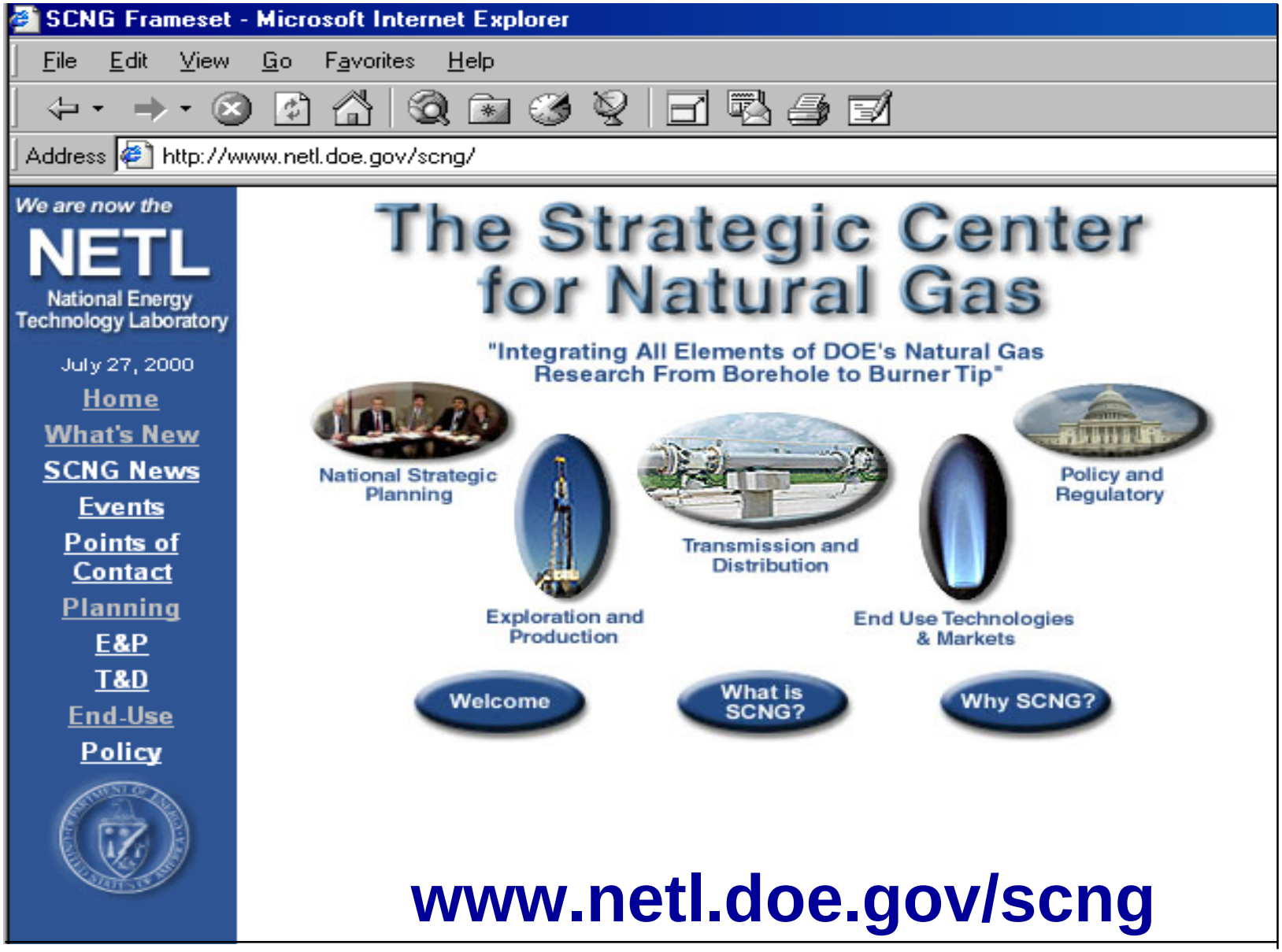
- **Use available feeds:**
  - Coal, gas, biomass, waste
- **Electricity is primary product**
  - May co-produce fuels, chemicals, steam, heat

Goal:

Absolutely Minimize Environmental Implications of Use of Fossil Energy!

Approach:

- **Maximize efficiency**
  - 60% coal-to-electric
  - 75% natural gas-to-electric
- **Near-zero emissions**
  - Option for carbon sequestration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Why SCNG?
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